CLAIMS

What is claimed is:

1. A $2^n \times 2^n$ generalized divide-and-conquer network, $n>1$, comprising

$2^{\lfloor n/2 \rfloor}$ $2^{\lceil n/2 \rceil} \times 2^{\lceil n/2 \rceil}$ input nodes,

$2^{\lceil n/2 \rceil}$ $2^{\lfloor n/2 \rfloor} \times 2^{\lfloor n/2 \rfloor}$ output nodes, and

an interstage exchange connecting the input nodes to the output nodes.

2. The generalized divide-and-conquer network as recited in claim 1 wherein the interstage exchange is a bit-permuting exchange induced by a permutation σ on integers from 1 to n such that σ maps the numbers $\lfloor n/2 \rfloor+1, \lfloor n/2 \rfloor+2, \ldots, n$, into the set $\{1, 2, \ldots, \lceil n/2 \rceil\}$ excluding the bit-permuting exchange equal to the $\lfloor n/2 \rfloor^{th}$ power of $SHUF^{(n)}$.

3. The generalized divide-and-conquer network as recited in claim 2 wherein

each of the $2^{\lfloor n/2 \rfloor}$ $2^{\lceil n/2 \rceil} \times 2^{\lceil n/2 \rceil}$ input nodes is a $2^{\lceil n/2 \rceil} \times 2^{\lceil n/2 \rceil}$ generalized divide-and-conquer network, and

each of the $2^{\lceil n/2 \rceil}$ $2^{\lfloor n/2 \rfloor} \times 2^{\lfloor n/2 \rfloor}$ input nodes is a $2^{\lfloor n/2 \rfloor} \times 2^{\lfloor n/2 \rfloor}$ generalized

divide-and-conquer network.

4. The generalized divide-and-conquer network as recited in claim 2 wherein the bit-permuting exchange is a $SWAP^{(n, r)}$ exchange.

5. A $2^n\times2^n$ generalized divide-and-conquer network associated with a n-leaf balanced binary tree, n>1, the network comprising

$2^{\lfloor n/2\rfloor}$ $2^{\lceil n/2\rceil}\times2^{\lceil n/2\rceil}$ input nodes,

$2^{\lceil n/2\rceil}$ $2^{\lfloor n/2\rfloor}\times2^{\lfloor n/2\rfloor}$ output nodes, and

an interstage exchange connecting the input nodes to the output nodes, wherein the interstage exchange is a bit-permuting exchange induced by a permutation σ on integers from 1 to n such that σ maps the numbers $\lfloor n/2\rfloor+1, \lfloor n/2\rfloor+2, \ldots, n$, into the set $\{1, 2, \ldots, \lceil n/2\rceil\}$ excluding the bit-permuting exchange equal to the $\lfloor n/2\rfloor^{th}$ power of $SHUF^{(n)}$.

6. A $2^n\times2^n$ generalized divide-and-conquer network, n>1, achieving an optimal layout complexity under the 2-layer Manhattan model with reversed layers and optimal structural modularity among all $2^n\times2^n$ banyan-type networks, the network comprising

$2^{\lfloor n/2\rfloor}$ $2^{\lceil n/2\rceil}\times2^{\lceil n/2\rceil}$ input nodes,

$2^{\lceil n/2 \rceil}$ $2^{\lfloor n/2 \rfloor} \times 2^{\lfloor n/2 \rfloor}$ output nodes, and

an interstage exchange connecting the input nodes to the output nodes,

wherein the interstage exchange is a bit-permuting exchange induced by a permutation σ on integers from 1 to n such that σ maps the numbers $\lfloor n/2 \rfloor+1, \lfloor n/2 \rfloor+2, \ldots, n$, into the set $\{1, 2, \ldots, \lceil n/2 \rceil\}$ excluding the bit-permuting exchange equal to the $\lfloor n/2 \rfloor^{th}$ power of $SHUF^{(n)}$.

7. A method for recursively constructing a $2^n \times 2^n$ generalized divide-and-conquer network, n>1, comprising

forming the bit-permuting 2-stage tensor product between a generalized $2^{\lceil n/2 \rceil} \times 2^{\lceil n/2 \rceil}$ divide-and-conquer network and a generalized $2^{\lfloor n/2 \rfloor} \times 2^{\lfloor n/2 \rfloor}$ divide-and-conquer network, and

recursively, each $2^k \times 2^k$ generalized divide-and-conquer network (k<n) is constructed by forming the bit-permuting 2-stage tensor product between a generalized $2^{\lceil k/2 \rceil} \times 2^{\lceil k/2 \rceil}$ divide-and-conquer network and a generalized $2^{\lfloor k/2 \rfloor} \times 2^{\lfloor k/2 \rfloor}$ divide-and-conquer network, until k=1, where a 2×2 generalized divide-and-conquer network is a single cell.

8. The method as recited in claim 7 wherein the forming includes

configuring a first stage of input nodes where each of the input nodes is a

generalized $2^{\lceil k/2 \rceil} \times 2^{\lceil k/2 \rceil}$ divide-and-conquer network,

configuring a second stage of output nodes where each of the output nodes is a generalized $2^{\lfloor k/2 \rfloor} \times 2^{\lfloor k/2 \rfloor}$ divide-and-conquer network, and

interconnecting the first stage and the second stage by a bit-permuting exchange induced by a permutation σ on integers from 1 to k such that σ maps the numbers $\lfloor k/2 \rfloor+1, \lfloor k/2 \rfloor+2, \ldots, k$, into the set $\{1, 2, \ldots, \lceil k/2 \rceil\}$ excluding the bit-permuting exchange equal to the $\lfloor k/2 \rfloor^{th}$ power of $SHUF^{(n)}$.

9. A method for recursively constructing a $2^n \times 2^n$ generalized divide-and-conquer network, n>1, in correspondence to an n-leaf balanced binary tree, the method comprising

constructing, in correspondence to the root R of the tree, the generalized $2^n \times 2^n$ generalized divide-and-conquer network by forming the bit-permuting 2-stage tensor product between a generalized $2^p \times 2^p$ divide-and-conquer network which is associated with the left-son of R having a weight of p and a generalized $2^q \times 2^q$ divide-and-conquer network which is associated with the right-son of R having a weight of q, with $|p-q| \leq 1$ and wherein $p=\lceil n/2 \rceil$ and $q=\lfloor n/2 \rfloor$, or $p=\lfloor n/2 \rfloor$ and $q=\lceil n/2 \rceil$, and

recursively, in correspondence to a generic internal node H with weight k until k=1 and wherein a 2×2 generalized divide-and-conquer network is a single cell.,

constructing a $2^k \times 2^k$ generalized divide-and-conquer network ($k<n$) by forming the bit-permuting 2-stage tensor product between a generalized $2^s \times 2^s$ divide-and-conquer network which is associated with the left-son of H having a weight of s and a generalized $2^t \times 2^t$ divide-and-conquer network which is associated with the right-son of H having a weight of t, with $|s-t| \leq 1$ and wherein $s=\lceil k/2 \rceil$ and $t=\lfloor k/2 \rfloor$, or $s=\lfloor k/2 \rfloor$ and $t=\lceil k/2 \rceil$.